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PART II

# DEPARTMENT OF LABOR

## Occupational Safety and Health Administration

■

# AGRICULTURAL TRACTORS

## Roll-Over Protective Structures

## Title 29—Labor

## CHAPTER XVII—OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPARTMENT OF LABOR

[S-74-2]

## PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

## PART 1928—OCCUPATIONAL SAFETY AND HEALTH STANDARDS FOR AGRICULTURE

### Roll-Over Protective Structures for Agricultural Tractors

Pursuant to section 6(b) of the Williams-Steiger Occupational Safety and Health Act of 1970 (84 Stat. 1593; 29 U.S.C. 655), Secretary of Labor's Order No. 12–71 (36 FR 8754), and 29 CFR Part 1911, Chapter XVII of Title 29, Code of Federal Regulations is hereby amended in the manner set forth below, in order to add a new Part 1928, "Occupational Safety and Health Standards for Agriculture," to include, in the new Part 1928, reference to the existing occupational safety and health standards applicable to agriculture, and to provide a new standard dealing with roll-over protective structures for agricultural tractors.

I. *Background.* Tractor roll-overs have been a major cause of employee injury and death on the farm. The Secretry of Labor recognized the need to deal with this problem when, in appointing the Standards Advisory Committee on Agriculture (hereafter referred to as "SACA") in June 1972, he made the area of roll-over protective structures (ROPS) a priority subject for a standard.

The SACA appointed a subcommittee on ROPS in July 1972. The subcommittee met in Washington, D.C. on October 18–19, 1972, and in Iowa City, Iowa on December 18–20, 1972. A final recommendation was presented by the subcommittee to the full committee on December 20, 1972, and was unanimously adopted by the full committee as its recommendation to the Assistant Secretary of Labor for Occupational Safety and Health.

On February 4, 1974 a notice of proposed rulemaking was published in the FEDERAL REGISTER (39 FR 4536) which contained a proposed new Part 1928 and a ROPS proposal which was substantially based on the recommendations of the SACA. The notice invited interested persons to submit written data, views and arguments concerning the proposal. Requests for an informal hearing were also invited. The proposal would have required all employee operated tractors of over 20 engine horsepower manufactured after a stated date and used in agricultural operations to be equipped with a seat belt and a ROPS that meet the test and performance requirements specified in the standard. The employer would have been required to assure that each employee used the seat belt. Following numerous requests for a hearing, a notice was published in the FEDERAL REGISTER on May 16, 1974 (39 FR 17448) scheduling an informal hearing on the proposal at four locations. One of the hearing dates and locations was subsequently changed. The hearing requests raised essentially six issues, which were specified in the notice of hearing as issues to be addressed at the hearing.

The informal public hearing was held on June 13, 1974 in Chicago, Illinois; on June 18, 1974 in Tallahassee, Florida; on June 20, 1974 in Washington, D.C.; and on June 25, 1974 in Boise, Idaho. Eleven written submissions were received by the SACA, and approximately 260 pages of testimony were received by the committee and subcommittee. In addition, over 670 written submissions were received in response to the proposal and approximately 770 pages of testimony and 123 exhibits were received at the hearing. The entire record encompassing these submissions was thoroughly reviewed and evaluated in reaching the determinations set forth below.

II. *The final standard.* (1) *Generally.* The final standard preserves the requirement contained in the proposal that all tractors manufactured after October 25, 1976 of over 20 engine horsepower used in agriculture be equipped with a seat belt and a ROPS that meet the test and performance requirements specified in the standard. However, the final standard, unlike the proposal, exempts from this requirement "low-profile tractors" while used in orchards, vineyards, hop yards and low-clearance buildings. Other tractors are also exempted while used in low-clearance buildings. In addition, tractors mounted with implements incompatible with a ROPS may be operated without a ROPS at the time of these usages. The final standard also requires the employer to ensure that all employees use the seat belt. In addition it requires employers to enforce prescribed operating rules whether or not a ROPS is required. Finally, each ROPS must contain a label which states, among other things, that the test and performance requirements contained in the standard have been met.

(2) *Issues involved in the proceeding.* The following issues were specified in the notice of hearing and were dealt with extensively at the hearing and in the written submissions.

(a) *Whether the proposed ROPS standard is reasonably necessary or appropriate to provide a safe place of employment.* This issue involves a determination of whether tractor roll-overs constitute a hazard from which employees should be protected, and if so, whether the ROPS systems proposed would prevent deaths and injuries from roll-overs.

Several major statistical studies of fatalities resulting from roll-overs have been made in the United States in recent years including the Department of Transportation study through 1969 (hereinafter referred to as "DOT study") (Exhibit (hereinafter "Exh.") 6) the National Safety Council study of 10 states for 1969–70 and 1971–72 (hereinafter referred to as "10 state study") analyzed in Exh. 7; and the National Safety Council data sheet, entitled "Concept of Development of Tractor Overturn Protection" (hereinafter referred to as "NSC data sheet") (Exh. 3). Several state studies were performed, but they are reflected in the DOT and NSC studies.

The DOT study indicates that roll-over tractor accidents are responsible for approximately 540 fatalities each year. The 10 state study indicates that the average annual death rate was 8.6 deaths per 100,000 tractors in 1971–72 and 8.5 deaths per 100,000 tractors in 1969–70. The NSC data sheet projects that for every 1000 reported roll-overs, 60 fatalities, 20 permanently disabling injuries and 450 temporarily disabling injuries will occur. It is therefore apparent that there are substantial hazards associated with tractor roll-overs.

There is virtually no dispute that a ROPS with a seat belt meeting the performance requirements of the final standard will significantly reduce the hazards associated with roll-overs. Dr. J. B. Liljedahl testified that because of their strength, ROPS protect employees against being crushed between the tractor and the ground in a tractor roll-over. In addition, a ROPS restricts most roll-overs to 90 degrees, thus reducing the likelihood of deaths or injuries resulting from roll-overs by preventing the tractor from fully rolling over on the employee. Finally, use of the required seat belt keeps the operator in the protective enclosure formed by the ROPS and prevents the operator from being thrown or jumping from the tractor, thus avoiding additional hazards such as the tractor rolling over the operator, or the operator being thrown into a stationary object. In Sweden, where ROPS are required, but seat belts are not required, 5 of the 8 reported fatalities resulting from roll-overs between 1959 and 1969 may well have been avoided if seat belts were in use when the roll-over occurred. (See Exh. 6, "Safety and Comfort Test Program—Swedish Approach".)

Moreover, the DOT study indicates that no known fatalities have occurred while using a ROPS in conjunction with a seat belt that met the ASAE and SAE standards upon which the OSHA standard is based (DOT study, p. 37). Similar findings have been made in other studies (see e.g., Hansen, "The Evolution of Tractor Design and Safety Features on Farm Tractors," DOT study p. 83; Kuhns, "Experiences with Anti-roll Bar Equipped Tractors," 1966 FIEI Engineering Seminar). Finally, tractor and ROPS manufacturers also agree that a ROPS which complies with the standard is an effective device for protecting the operator from fatality or serious injuries in a tractor upset. (See e.g., Deere & Co., Transcript (hereinafter "Tr.") I–123.)

Accordingly, it is concluded that a ROPS standard is reasonably necessary and appropriate to provide a safe place of employment.

(b) *Whether it is feasible to require ROPS in certain low clearance situations, such as in orchards, vineyards, hop yards, and in farm buildings and green-houses.* Initially it should be noted that although the SACA did not make specific recommendations as to exemptions from the ROPS requirements, it recognized that the record in the rulemaking proceeding

may establish the need for some exemptions (SACA, December 20, 1972, Tr. 47). Mmany growers testified that the trend in orchard growing is to plant dwarf trees close together so that the fruit can be harvested from the ground or with short ladders. Improved employee safety and increased efficiency in harvesting have resulted from the use of dwarf trees in orchards. This practice has caused many growers to use "low-profile" tractors, which are capable of moving around, under and between these trees without causing injury to the operator or damaging the trees (see e.g. Tr. III–150 and 151). In fact, other tractors, with or without a ROPS, are too high to avoid the low-hanging limbs of these dwarf trees. Growers suggested that application of the standard's ROPS requirement for "low-profile" tractors would increase the height of the vehicle and severely limit the "low-profile" tractor's ability to move under, around and between these dwarf trees. In essence, a ROPS requirement would effectively preclude the practice of dwarfing trees, thus creating hazards associated with the use of taller ladders. In addition, harvesting efficiency would be severely hampered. "Low-profile" tractors are also used in vineyards and hop yards, for essentially the same reasons they are used in orchards. Growers have argued that application of the ROPS requirements to them would also be unduly burdensome (see e.g. Tr. IV–147–155). Growers and manufacturers testified that "low-profile" tractors are less prone to roll-overs than field tractors because they are built low to the ground; have an extremely low center of gravity; and are generally driven at 2–3 miles per hour (e.g., Tr. I–100).

Attempts to develop a ROPS for low-profile tractors which provide adequate protection in the event of a roll-over, while allowing the tractor to operate normally around dwarf trees, vineyards and hop yards have thus far been unsuccessful (see e.g. Tr. I–129–130). Manufacturers have testified that there is presently no design or test procedure for such ROPS. The State of California, which will require the use of a ROPS on low-profile tractors, has authorized submission of low-profile ROPS designs to the State for approval, but none have been approved to date.

Those who favor requiring a ROPS on "low-profile" tractors argue that "low-profile" tractors are subject to roll-overs and should therefore not be exempted.

The accident statistics regarding roll-overs in orchards, vineyards and hop yards are, at best, meager. The DOT and NSC studies do not reflect the percentage of roll-overs in orchards. Nor do they reflect the type of tractor which was involved. The California study contains the only available statistics on roll-overs in orchards. Between January 1969 and April 1974 eight orchard fatalities resulting from roll-overs were reported. These statistics are of limited value because the type of tractor involved was not always available, and we do not know how many "low-profile" tractors were in use during that time and how many of the fatalities occurred in "low-profile" tractors.

After weighing all of the above considerations, we have decided to exempt "low-profile" tractors from the ROPS requirements of the standard while they are used in specified low clearance situations, and while their use is incidental to the work performed in such low clearance situations.

It is apparent that a definition of "low-profile tractor" is necessary. Such a definition, based on manufacturers' testimony received at the public hearings, and in post hearing comments, is included in the final rule in § 1928.51. We feel this definition will insure that exempted "low-profile" tractors will be relatively stable and provide some flexibility in the selection of tractors by employers. This, in combination with the operating instructions discussed below, will provide substantial roll-over protection for employee operators of "low-profile" tractors.

Several witnesses suggested that a ROPS is infeasible for tractors while they are used inside many farm buildings because entrances to many of these buildings are lower than tractors equipped with a ROPS. And, alteration of entrances and ceilings to accommodate a ROPS could threaten the structural integrity of some buildings. Considering that these tractors are often of the low-profile variety (Tr. I–43), that they are used at extremely low speeds when operating indoors and that substantial economic consequences would result if a ROPS were required in this situation (e.g. Tr. I–43, 53, 65), we have decided not to require a ROPS on low-profile tractors while they are used in such low-clearance situations, and while their use is incidental to the work performed therein.

A representative of the Society of American Florists and Ornamental Horticulturists testified (Tr. III–26–30) that low-profile tractors of over 20 horsepower are used in low clearance green-houses; that these tractors operate at minimal speeds; and that due to the narrow width of aisles, and the lack of slopes, ditches, embankments, or holes, the possibility of roll-over is extremely remote. There is no evidence of tractor roll-over occurring in this type of situation. Accordingly, we have decided not to require a ROPS on low-profile tractors while they are used in low clearance green-houses, and while their use is incidental to the work performed therein.

It should be noted that these exemptions (contained in § 1928.51(b)(5) (i) and (ii)) apply only during the uses specified therein or in uses incidental thereto. The ROPS requirements of the standard apply where a tractor, including a "low-profile" tractor, is operated by an employee in non-exempted situations even if that tractor is sometimes used in exempted situations. We recognize that this will make it necessary for employers either to confine the operation of such tractors by employees to the uses specified in § 1928.51(b)(5) (i) and (ii), or to remove the ROPS for the exempted uses and remount the ROPS for the non-exempted uses. While this requirement may be burdensome to some employers, we do not believe it appropriate to exempt a tractor while it is performing a typical agricultural function simply because certain of that tractor's uses are exempted. Rather, we believe it is necessary and appropriate to require a ROPS during all non-exempt uses except those merely incidental to the exempted use.

Although "low-profile" tractors are less prone to roll-overs than field tractors, they are nonetheless subject to roll-over when used in typical field operations. In short, the compelling safety and productivity considerations which led us to exempt the uses set forth in (b)(5) (i) and (ii) do not exist with respect to the non-exempted uses.

(c) *Whether ROPS should be required on tractors used in the vicinity of drainage canals.* This issue was raised primarily by sugar cane and citrus growers in the southeast. Several witnesses argued that a ROPS with seat belts would be more hazardous to an employee than no protection, because in the event of a roll-over into a drainage canal, the fastened seatbelt would prevent the employee from leaping free of the tractor and would in effect cause the employee to drown by trapping him underwater (see e.g. Tr. II–20–23). However, since a ROPS with a seat belt are apparently not used near drainage canals, no such incidents were reported. Other witnesses suggested that the danger from drowning when ROPS with a seat belt were used is far less than the chance of being crushed when no protection is provided, because the operator, upon landing in the canal, could unfasten the seat belt and escape (see Tr. III–64, IV–231). Moreover, the record evidence demonstrates that deaths have resulted from roll-overs into drainage canals where ROPS with a seat belt were not in use (see e.g. Ex. 104, Tr. IV–231). And, since these deaths occurred because the operator was trapped between the tractor and the mud, we believe a ROPS with a seat belt may well have have saved these operators' lives.

In weighing the known hazards of roll-overs into canals where a ROPS with a seat belt were not used, against the potential hazard of drowning because a seat belt is used, we have concluded that where tractors are used in the vicinity of drainage canals, the use of a ROPS with a seat belt is necessary and appropriate to protect operators from the hazards associated with roll-overs. Accordingly, we decline to exempt drainage canal usage from the requirements of the standard.

(d) *What type of labeling should be required on the ROPS.* The proposal would have required a label on each ROPS which indicates, among other things, the date the ROPS was manufactured and the type of test performed upon the ROPS. Several manufacturers objected to these requirements because there is no need to specify the date of the manufacture of the ROPS device, since the ROPS requirement is dependent upon the manufacture date of the tractor, not the ROPS. Moreover, they

argued that a statement of the type of test performed is unnecessary because the label itself would indicate to the employer that the manufacturer was certifying that the tractor was equipped with a properly tested ROPS. They further contended that the date of manufacture of the tractor is unnecessary because it can easily be determined by the serial number. We have decided that since the date of manufacture of the ROPS device is irrelevant, the date of manufacture of the tractor can be determined from the serial number, and a listing of the types of tests performed on a ROPS model would serve no necessary purpose, it is proper to delete that part of the labeling requirements found in § 1928.51(d) (4) and (5) of the proposal and not to impose an obligation to list the date of manufacture of the tractor. However, the final standard, unlike the proposal, requires each ROPS label to contain a statement that the ROPS model was tested in accordance with the requirements of the standard.

(e) *What the effective date of the ROPS standard should be.* The proposed effective date for the ROPS standard, September 1, 1974, has already passed. In the written comments and at the hearings, manufacturers argued that a greater lead time was necessary in order to meet the anticipated increased demand for ROPS that will be generated if a final rule is promulgated. Lead times suggested ranged from 9 months to two years. In support of their suggestions for a longer lead time, manufacturers cited a steel shortage, the need for adding plant facilities for manufacture and storage of ROPS devices, and the need to retool. They testified that the special grade of steel necessary for making ROPS was in particularly short supply, and supplied documentation from steel suppliers indicating the impossibility of getting such steel without a substantial lead time. (See, e.g., Tr. I–78–157, Ex. 17, 17A, 16, Comment 679). No one disputed the manufacturers' claim. After a careful review of the relevant testimony, we believe that the manufacturers will be able to meet the increased demand generated by this standard in 18 months. Accordingly, all tractors manufactured after October 25, 1976, and operated by employees must be equipped with a ROPS and seat belt that meet the requirements of this standard.

(f) *Whether ROPS should be required on track-type tractors used in agricultural operations.* The proposal would have required a ROPS on track-type tractors. Many witnesses, primarily wheat growers from the Northwest, testified that track-type vehicles used in their normal crop tillage operations on steep hills are not prone to roll-overs; that there was little or no evidence of fatalities from such roll-overs in wheat farming; that heavy weight and low center of gravity made these tractors less susceptible to side roll-over; and that track type tractors are never used on roads, thus reducing a major source of roll-overs (e.g. Tr. IV–70–76, 185–188, 207). On the other hand, while there have been no statistical multi-state or national studies of track-type tractor roll-overs, the record evidence demonstrates that track-type tractors used in agriculture do, indeed, roll over. (See e.g. Tr. IV–177–178, 220, Ex. 104, SACA Subcommittee on ROPS, 12/19/72–22, 54–55). Moreover, it was demonstrated that track type tractors are generally used in operations which are too hazardous for wheel-type tractors, such as towing of heavy loads, use on steep hills, and packing of silage, as well as in construction and logging operations, where there is general agreement that a ROPS should be required (see e.g. Tr. IV–68, 71, 185, 186). Furthermore, hazards from deep ditches or during unloading of tractors via ramp from trucks are not demonstrably less for track-type tractors than for wheel-types. Finally, there was also evidence that most track-type vehicles are purchased with cabs for comfort reasons (primarily noise and weather protection) and that all cabs now manufactured meet the requirements of the standard anyway (e.g. Tr. I–101–102). After weighing all of the above considerations, we have decided not to exempt track-type tractors from the requirements of the standard.

(3) Several other issues arose at the hearing which merit some comment:

(a) *Whether a training program is necessary or appropriate.* It was suggested, particularly by the Farm and Industrial Equipment Institute, that a section should be added to the standard dealing with safe operating practices for tractors. The emphasis on training and education as a means of preventing accidents had been suggested by numerous witnesses and commenters (e.g., Dr. Liljedahl, Tr. I–28), and a new § 1928.51(d) has been added, requiring tractor operators to be trained as to the hazards associated with roll-overs and how to prevent roll-overs. This new paragraph will be effective on June 1, 1975, and will apply to all agricultural tractors used by employees, including those presently in use and those specifically exempted from the use of a ROPS by the provisions of the final rule.

(b) *Whether it is feasible to require ROPS where certain types of tractor mounted equipment is used.* Several manufacturers and employers (e.g. International Harvester, Tr. I–79–87; Green Giant Company, Tr. I–154–159) stated that mounted corn-pickers and cotton strippers, as well as other implements, are incompatible with a ROPS, because such implements are located where a ROPS would be attached. Testimony indicates that this mounted equipment provides roll-over protection, in that roll-overs to the rear and front are nearly impossible (Tr. 1–79–87, 96), while roll-overs to the side would normally be limited to 90 degrees. Balancing the need for protection against the impracticability of requiring a ROPS in this type of situation, we have decided to add § 1928.51(b)(5)(iii), which allows tractors to be operated without ROPS when certain types of equipment are mounted on that tractor. A list of such equipment, not intended to be all inclusive, is set forth in the standard. As with the other exemptions contained in paragraph (b)(5), the standard requires the reinstallation of the ROPS when the mounted equipment is removed from the tractor.

(c) *Whether zero degree static testing should be permitted.* Representatives of an independent ROPS cab manufacturer argued that the zero degree testing requirements contained in § 1928.52 (e)(1)(ii) and § 1928.53(e)(1)(ii) of the proposed standard were unduly restrictive and would cause them to discontinue the manufacture of ROPS because zero degree static testing was not permitted by the proposal. They further suggested that the static test at zero degrees was a "good simulation" of the average roll-over at that temperature; that this restriction penalized the small independent manufacturer of ROPS who does not have the facilities or financial resources to acquire the necessary tools and materials for dynamic testing of ROPS; that the construction ROPS standard (§ 1926.1001 (f)(2)(iv)) permits such testing; and that there is no good reason for the difference between the construction requirement and the proposed agricultural requirement with respect to this test. In addition, the one metal which need not be tested at zero degrees is difficult to obtain (Charpy V-notch material). It appears that these comments are meritorious, and the final rule has been changed to allow static zero degree testing.

(d) *Whether retrofitting should be required.* The proposal did not contain a retrofitting requirement. However, one witness and several commenters suggested that the final standard should contain a delayed retrofitting requirement for ROPS. They pointed to the California ROPS regulation which requires retrofitting on all tractors by 1978. However, several witnesses at the hearing testified that the frames of many older tractors would be incapable of supporting a ROPS during a roll-over, and that a retrofitting requirement would impose an unreasonable economic burden because ROPS would have to be custom made for many older tractors. No specific evidence was presented which shows that retrofitting is feasible. Also, the SACA subcommittee on ROPS did not include a retrofit provision in its recommendations to the Assistant Secretary. Its recommendations noted, among other things, that the uses of older tractors decline as the tractors get older; that a majority of the work is performed by newer tractors; and that the cost of retrofit would therefore not be justified. (e.g., SACA Subcommittee on ROPS, 12/19/72–128–133; SACA, 12/20/72–52–77)

Based upon the foregoing, we decline to require retrofitting at this time.

As proposed, we have added a new Part 1928, entitled "Occupational Safety and Health Standards for Agriculture." Inasmuch as agricultural operations are treated separately from general industry, we believe that it is appropriate to establish a separate part in Chapter

XVII of 29 CFR to include all occupational safety and health standards applicable to agricultural operations.

In addition, we have redesignated § 1910.267 (a) and (b), which reference the general industry standards that apply to agricultural operations, as § 1928.21 (a) and (b). Since this is merely a redesignation, with minor editorial changes, we find that rulemaking proceedings under section 6(b) of the Act or under 5 U.S.C. 553 are unnecessary.

Accordingly, upon consideration of the whole record of this proceeding, Chapter XVII of Title 29, Code of Federal Regulations, is hereby amended by adding a new Part 1928, by redesignating § 1910.267 (a) and (b), with minor editorial changes, as § 1928.21 (a) and (b), by adding a new standard on ROPS for agricultural tractors as §§ 1928.51, 1928.52, and 1928.53, and by inserting in § 1910.267 a reference to § 1928.21, reading as follows:

Subpart A—General

Sec.
1928.1 Purpose and scope.

Subpart B—Applicability of Standards

1928.21 Applicable standards in 29 CFR Part 1910.

Subpart C—Roll-Over Protective Structures

1928.51 Roll-over protective structures (ROPS) for tractors, used in agricultural operations.
1928.52 Protective frames for wheel type agricultural tractors-test procedures and performance requirements.
1928.53 Protective enclosures for wheel type agricultural tractors-test procedures and performance requirements.

AUTHORITY: Sec. 6 (b), Pub. L. 91-596, 84 Stat. 1593 (29 U.S.C. 655), Secretary of Labor's Order No. 12-71, 36 FR 8754.

## Subpart A—General

### § 1928.1 Purpose and scope.

This part contains occupational safety and health standards applicable to agricultural operations.

## Subpart B—Applicability of Standards

### § 1928.21 Applicable standards in 29 CFR Part 1910.

(a) The following standards in Part 1910 of this Chapter shall apply to agricultural operations:

(1) Temporary labor camps—§ 1910.142;

(2) Storage and handling of anhydrous ammonia—§ 1910.111 (a) and (b);

(3) Pulpwood logging—§ 1910.266;

(4) Slow-moving vehicles—§ 1910.145.

(b) Except to the extent specified in paragraph (a) of this section, the standards contained in Subparts B through S of Part 1910 of this title do not apply to agricultural operations.

## Subpart C—Roll-Over Protective Structures

### § 1928.51 Roll-over protective structures (ROPS) for tractors used in agricultural operations.

(a) *Definitions.* As used in this subpart—

*"Agricultural tractor"* means a two- or four-wheel drive type vehicle, or track vehicle, of more than 20 engine horsepower, designed to furnish the power to pull, carry, propel, or drive implements that are designed for agriculture. All self-propelled implements are excluded.

*"Low profile tractor"* means a wheeled tractor possessing the following characteristics:

(1) The front wheel spacing is equal to the rear wheel spacing, as measured from the centerline of each right wheel to the centerline of the corresponding left wheel.

(2) The clearance from the bottom of the tractor chassis to the ground does not exceed 18 inches.

(3) The highest point of the hood does not exceed 60 inches, and

(4) The tractor is designed so that the operator straddles the transmission when seated.

*"Tractor weight"* includes the protective frame or enclosure, all fuels, and other components required for normal use of the tractor. Ballast shall be added as necessary to achieve a minimum total weight of 110 lb. (50.0 kg.) per maximum power take-off horsepower at the rated engine speed or the maximum gross vehicle weight specified by the manufacturer, whichever is the greatest. Front end weight shall be at least 25 percent of the tractor test weight. In case power take-off horsepower is not available, 95 percent of net engine flywheel horsepower shall be used.

(b) *General requirements.* Agricultural tractors manufactured after October 25, 1976, shall meet the following requirements:

(1) *Roll-over protective structure.* A roll-over protective structure (ROPS) shall be provided by the employer for each tractor operated by an employee. Except as provided in paragraph (b)(5) of this section, ROPS used on wheel type tractors shall meet the test and performance requirements of § 1928.52 or § 1928.53 of this part or § 1926.1002 of Part 1926, and ROPS used on track type tractors shall meet the test and performance requirements of § 1926.1001 of Part 1926.

(2) *Seatbelts.* (i) Where ROPS are required by this section, the employer shall:

(A) Provide each tractor with a seatbelt which meets the requirements of this paragraph;

(B) Ensure that each employee uses such seatbelt while the tractor is moving; and

(C) Ensure that each employee tightens the seatbelt sufficiently to confine the employee to the protected area provided by the ROPS.

(ii) Each seatbelt shall meet the requirements set forth in Society of Automotive Engineers Standard SAE J4C, 1965 Motor Vehicle Seat Belt Assemblies,[1] except as noted hereafter:

(A) Where a suspended seat is used, the seatbelt shall be fastened to the movable portion of the seat to accommodate a ride motion of the operator.

(B) The seatbelt anchorage shall be capable of withstanding a static tensile load of 1,000 pounds (453.6 kg) at 45 degrees to the horizontal equally divided between the anchorages. The seat mounting shall be capable of withstanding this load plus a load equal to four times the weight of all applicable seat components applied at 45 degrees to the horizontal in a forward and upward direction. In addition, the seat mounting shall be capable of withstanding a 500 pound (226.8 kg) belt load plus two time the weight of all applicable seat components both applied at 45 degrees to the horizontal in and upward and rearward direction. Floor and seat deformation is acceptable provided there is not structural failure or release of the seat adjusted mechanism or other locking device.

(C) The seatbelt webbing material shall have a resistance to acids, alkalies, mildew, aging, moisture, and sunlight equal to or better than that of untreated polyester fiber.

(3) *Protection from spillage.* Batteries, fuel tanks, oil reservoirs, and coolant systems shall be constructed and located or sealed to assure that spillage will not occur which may come in contact with the operator in the event of an upset.

(4) *Protection from sharp surfaces.* All sharp edges and corners at the operator's station shall be designed to minimize operator injury in the event of an upset.

(5) *Exempted uses.* Paragraphs (b)(1) and (b)(2) of this section do not apply to the following uses:

(i) "Low profile" tractors while they are used in orchards, vineyards or hop yards where the vertical clearance requirements would substantially interfere with normal operations, and while their use is incidental to the work performed therein.

(ii) "Low profile" tractors while used inside a farm building or greenhouse in which the vertical clearance is insufficient to allow a ROPS equipped tractor to operate, and while their use is incidental to the work performed therein.

(iii) Tractors while used with mounted equipment which is incompatible with ROPS (e.g. cornpickers, cotton strippers, vegetable pickers and fruit harvesters).

(6) *Remounting.* Where ROPS are removed for any reason, they shall be remounted so as to meet the requirements of this paragraph.

(c) *Labeling.* Each ROPS shall have a label, permanently affixed to the structure, which states

(1) Manufacturer's or fabricator's name and address;

(2) ROPS model number, if any;

(3) Tractor makes, models, or series numbers that the structure is designed to fit; and

(4) That the ROPS model was tested in accordance with the requirements of this Subpart.

[1] Copies may be obtained from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pa. 15096.

(d) *Operating Instructions.* Every employee who operates an agricultural tractor shall be informed of the operating practices contained in Appendix A of this part and of any other practices dictated by the work environment. Such information shall be provided at the time of initial assignment and at least annually thereafter.

**§ 1928.52 Protective frames for wheel type agricultural tractors—test procedures and performance requirements.**

(a) *Purpose.* The purpose of this section is to establish the test and performance requirements for a protective frame designed for wheel-type agricultural tractors to minimize the frequency and severity of operator injury resulting from accidental upsets. General requirements for the protection of operators are specified in § 1928.51.

(b) *Types of tests.* All protective frames for wheel type agricultural tractors shall be of a model which has been tested as follows:

(1) *Laboratory test.* A laboratory energy absorption test, either static or dynamic, under repeatable and controlled loading, to permit analysis of the protective frame for compliance with the performance requirements of this standard.

(2) *Field upset test.* A field upset test under controlled conditions, both to the side and rear, to verify effectiveness of the protective system under actual dynamic conditions. Such test may be omitted where:

(i) the analysis of the protective frame static energy absorption test results indicates that both $FER_{ss}$ and $FER_{sr}$ (as defined in paragraph (d) (2) (ii) of this section), exceed 1.15; or

(ii) the analysis of the protective frame dynamic energy absorption test results indicates that the frame can withstand an impact of 15 percent greater than the impact it is required to withstand for the tractor weight as shown in Figure C–7.

(c) *Description*—(1) *Protective frame.* A protective frame is a structure comprised of uprights mounted to the tractor, extending above the operator's seat. A typical 2-post frame is shown in Figure C–1. (Figures C–1 through C–16 are contained in Appendix B.)

(2) *Overhead weather shield.* If an overhead weather shield is available for attachment to the protective frame, it may be in place during tests, providing it does not contribute to the strength of the protective frame.

(3) *Overhead falling object protection.* If an overhead falling object protection device is available for attachment to the protective frame, it may be in place during tests provided it does not contribute to the strength of the protective frame.

(d) *Test procedures*—(1) *General.* (i) The tractor weight used shall be that of the heaviest tractor model on which the protective frame is to be used.

(ii) Each test required under this section shall be performed on a new protective frame. Mounting connections of the same design shall be used during each such test.

(iii) Instantaneous deflection shall be measured and recorded for each segment of the test. See paragraph (e) (1) (i) of this section for permissible deflection.

(iv) Seat reference point (*SRP*) in Fig. C–3) is that point where the vertical line that is tangent to the most forward point at the longitudinal seat centerline of the seat back, and the horizontal line that is tangent to the highest point of the seat cushion intersect in the longitudinal seat section. The seat reference point shall be determined with the seat unloaded and adjusted to the highest and most rearward position provided for seated operation of the tractor.

(v) Where the centerline of the seat is off the longitudinal center, the frame loading shall be on the side with the least space between the centerline of seat and the protective frame.

(vi) Low temperature characteristics of the protective frame or its material shall be demonstrated as specified in paragraph (e) (1) (ii) of this section.

(vii) Rear input energy tests (static, dynamic, or field upset) need not be performed on frames mounted to tractors having 4 driven wheels and more than one-half their unballasted weight on the front wheels.

(viii) Accuracy table:

| *Measurements* | *Accuracy* |
|---|---|
| Deflection of frame, inches (millimeters) | ±5 percent of deflection measured. |
| Vehicle weight, pounds (kilograms) | ±5 percent of the weight measured. |
| Force applied to frame, pounds force (newtons). | ±5 percent of force measured. |
| Dimensions of critical zone, inches (millimeters). | ±0.5 inch (12.5 millimeters). |

(2) *Static test procedure.* (i) The following test conditions shall be met:

(A) The laboratory mounting base shall be the tractor chassis for which the protective frame is designed, or its equivalent.

(B) The protective frame shall be instrumented with the necessary equipment to obtain the required load deflection data at the locations and directions specified in Fig. C–2 and C–3.

(C) If the protective frame is of a one or two upright design, mounting connections shall be instrumented with the necessary equipment to record the required force to be used in paragraph (d) (2) (iii) (E) and (J) of this section. Instrumentation shall be placed on mounting connections before installation load is applied.

(ii) The following definitions shall apply:

$W$ = Tractor weight (see § 1928.51 (a)) in lb. ($W'$ in kg.).

$E_{ss}$ = Energy input to be absorbed during side loading in ft-lb ($E'_{ss}$ in m-kg.).

$E_{ss} = 723 + 0.4\,W$ ($E'_{ss} = 100 + 0.12\,W'$).

$E_{sr}$ = Energy input to be absorbed during rear loading in ft-lb ($E'_{sr}$ in m-kg.).

$E_{sr} = 0.47\,W$ ($E'_{sr} = 0.14\,W'$).

$L$ = Static load, lbf [pounds force], (N) [newtons].

$D$ = Deflection under $L$, in. (mm).

$L$–$D$ = Static load-deflection diagram.

$L_{max}$ = Maximum observed static load.

Load Limit = Point on a continuous $L$–$D$ curve where observed static load is 0.6 $L_{max}$ on down slope of curve (refer to Fig. C–5).

$E_a$ = Strain energy absorbed by the frame, ft-lb (m-kg.). Area under $L$–$D$ curve.

$FER$ = Factor of energy ratio.

$$FER_{ss} = \frac{E_a}{E_{ss}}$$

$$FER_{sr} = \frac{E_a}{E_{sr}}$$

$P_b$ = Maximum observed force in mounting connection under static load, $L$ lbf (N).

$P_a$ = Ultimate force capacity of mounting connection, lbf (N).

$FSB$ = Design margin for mounting connection.

$$FSB = \frac{P_a}{P_b}$$

(iii) The test procedures shall be as follows:

(A) Apply the rear load in accordance with Fig. C–3 and record $L$ and $D$ simultaneously. Rear load application shall be uniformly distributed on the frame over an area perpendicular to the direction of load application, no greater than 160 sq. in. (1032 sq. cm.) in size, with the largest dimension no greater than 27 inches (686 mm). The load shall be applied to the upper extermity of the frame at the point which is midway between the center of the frame and the inside of the frame upright. If no structural cross member exists at the rear of the frame, a substitute test beam which does not add strength to the frame may be utilized to complete this test procedure. The test shall be stopped when:

(*1*) The strain energy absorbed by the frame is equal to or greater than the required input energy $E_{sr}$, or;

(2) Deflection of the frame exceeds the allowable deflection (see paragraph (e) (1) (i) of this section) or;

(3) Frame load limit (see Figure C–5) occurs before the allowable deflection is reached in rear load.

(B) Using data obtained in paragraph (d) (2) (iii) (A) of this section, construct the $L$–$D$ diagram as shown typically in Fig. C–5.

(C) Calculate $E_{sr}$.

(D) Calculate $FER_{sr}$.

(E) Calculate $FSB$ where required by paragraph (d) (2) (i) (C) of this section.

(F) Apply the side load tests on the same frame and record $L$ and $D$ simultaneously. Side load application shall be at the upper extremity of the frame at a 90 degree angle to the center line of the vehicle. The side load shall be ap-

plied to the longitudinal side farthest from the point of rear load application. Apply side load $L$ as shown in Fig. C–2. The test shall be stopped when:

(1) The strain energy absorbed by the frame is equal to or greater than the required input energy $E_i$, or;

(2) Deflection of the frame exceeds the allowable deflection (see paragraph (e)(1)(i) of this section) or;

(3) Frame load limit (see Figure C–5) occurs before the allowable deflection is reached in side load.

(G) Using data obtained in paragraph (d)(2)(iii)(F) of this section, construct the L–D diagram as shown typically in Fig. C–5.

(H) Calculate $E_i$.

(I) Calculate $FER_i$.

(J) Calculate *FSB* where required by paragraph (d)(2)(i)(C) of this section.

(3) *Dynamic test procedure.* (i) The following test conditions shall be met:

(A) The protective frame and tractor shall be tested at the weight as defined in § 1928.51(a).

(B) The dynamic loading shall be accomplished by use of a 4410 lb. (2000 kg) weight acting as a pendulum. The impact face of the weight shall be 27±1 in. by 27±1 in. (686±25 mm by 686±25 mm) and shall be constructed so that its center of gravity is within 1 in. (25.4 mm) of its geometric center. The weight shall be suspended from a pivot point 18 to 22 ft. (5.5–6.7 m) above the point of impact on the frame and shall be conveniently and safely adjustable for height (See Fig. C–6).

(C) For each phase of testing, the tractor shall be restrained from moving when the dynamic load is applied. The restraining members shall have strength no less than, and elasticity no greater than, that of 0.50 in. (12.7 mm) steel cable. Points of attachment of restraining members shall be located an appropriate distance behind the rear axle and in front of the front axle to provide a 15 to 30 degree angle between a restraining cable and the horizontal. For the impact from the rear, the restraining cables shall be located in the plane in which the center of gravity of the pendulum will swing, or alternatively, two sets of symmetrically located cables may be used at lateral locations on the tractor. For impact from the side, restraining cables shall be used as shown in Figures C–8 and C–9.

(D) The front and rear wheel tread settings, where adjustable, shall be at the position nearest to halfway between the minimum and maximum settings obtainable on the vehicle. Where only two settings are obtainable, the minimum setting shall be used. The tires shall have no liquid ballast and shall be inflated to the maximum operating pressure recommended by the manufacturer. With specified tire inflation, the restraining cable shall be tightened to provide tire deflection of 6 to 8 percent of nominal tire section width. After the vehicle is properly restrained, a wooden beam no less than 6 x 6 in. (150 x 150 mm) cross section shall be driven tightly against the appropriate wheels and clamped. For the test to the side, an additional wooden beam shall be placed as a prop against the wheel nearest the operator's station and shall be secured to the base so that it is held tightly against the wheel rim during impact. The length of this beam shall be chosen so that it is at an angle of 25 to 40 degrees to the horizontal when it is positioned against the wheel rim. It shall have a length 20 to 25 times its depth and a width 2 to 3 times its depth. (See Figs. C–8 and C–9).

(E) Means shall be provided for indicating the maximum instantaneous deflection along the line of impact. A simple friction device is illustrated in Fig. C–4.

(F) No repairs or adjustments shall be made during the test.

(G) If any cables, props, or blocking shift or break during the test, the test shall be repeated.

(ii) $H$=Vertical height of center of gravity of 4410 lb. (2000 kg) weight in inches ($H'$ in mm). The weight shall be pulled back so that the height of its center of gravity above the point of impact is:

$H=4.92+0.00190\ W$ or $H'=125+0.170\ W'$) (Fig. C–7).

(iii) The test procedures shall be as follows:

(A) The frame shall be evaluated by imposing dynamic loading from the rear followed by a load to the side on the same frame. The pendulum swinging from the height determined by paragraph (d)(3)(ii) of this section shall be used to impose the dynamic load. The position of the pendulum shall be so selected that the initial point of impact on the frame is in line with the arc of travel of the center of gravity of the pendulum. Where a quick release mechanism is used, it shall not influence the attitude of the block.

(B) Impact at rear: The tractor shall be properly restrained in accordance with paragraphs (d)(3)(i)(C) and (d)(3)(i)(D) of this section. The tractor shall be positioned with respect to the pivot point of the pendulum so that the pendulum is 20 degrees from the vertical prior to impact as shown in Fig. C–8. The impact shall be applied to the upper extremity of the frame at the point which is midway between the center line of the frame and the inside of the frame upright. If no structural cross member exists at the rear of the frame, a substitute test beam which does not add to the strength of the frame may be utilized to complete the test procedure.

(C) Impact at side: The blocking and restraining shall conform to paragraphs (d)(3)(i)(C) and (d)(3)(i)(D) of this section. The point of impact shall be at the upper extremity of the frame at a point most likely to hit the ground first and at a 90 degree angle to the center line of the vehicle as shown in Fig. C–9. The side impact shall be applied to the longitudinal side farthest from the point of rear impact.

(4) *Field upset test procedure.* (i) The following test conditions shall be met:

(A) The tractor shall be tested at the weight as defined in § 1928.51(a).

(B) The test shall be conducted on a dry, firm soil bank. The soil in the impact area shall have an average cone index in the 0 to 6 inch (0 to 152 mm) layer of not less than 150. Cone index shall be determined in accordance with American Society of Agricultural Engineers Recommendation ASAE R313.1, Soil Cone Penetrometer (1971).[1] The path of vehicle travel shall be 12±2 degrees to the top edge of the bank.

(C) An 18 in. (457 mm) high ramp as described in Fig. C–10 shall be used to assist in upsetting the vehicle to the side.

(D) The front and rear wheel tread settings, where adjustable, shall be at the position nearest to halfway between the minimum and maximum settings obtainable on the vehicle. Where only two settings are obtainable, the minimum setting shall be used.

(ii) Field upsets shall be induced to the rear and side.

(A) Rear upset shall be induced by engine power with the tractor operating in a gear to obtain 3 to 5 MPH (4.8 to 8.0 km per hour) at maximum governed engine rpm by driving forward directly up a minimum slope of 60°±5° as shown in Fig. C–11 or by an alternative equivalent means. The engine clutch may be used to aid in inducing the upset.

(B) To induce side upset, the tractor shall be driven under its own power along the specified path of travel at a minimum speed of 10 MPH (16 km per hour), or at maximum vehicle speed if under 10 MPH (16 km per hour), and over the ramp as described in paragraph (d)(4)(i)(C) of this section.

(e) *Performance requirements*—(1) *General requirements.* (i) The frame, overhead weather shield, fenders, or other parts in the operator area may be deformed in these tests but shall not shatter or leave sharp edges exposed to the operator, or encroach on the dimensions shown in Figs. C–2 and C–3 as follows:

$d$=2 in. (51 mm) inside of frame upright to vertical center line of seat.

$e$=30 in. (762 mm) at the longitudinal centerline.

$f$=Not greater than 4 in. (102 mm) to rear edge of crossbar, measured forward of the seat reference point (*SRP*).

$g$=24 in. (610 mm) minimum.

$m$=Not greater than 12 in. (305 mm) measured from *SRP* to forward edge of crossbar.

(ii) The protective structure and connecting fasteners must pass the static or dynamic tests described in paragraphs (d)(2), (d)(3), or (d)(4) of this section at a metal temperature of 0 degrees fahrenheit or below, or exhibit Charpy V-notch impact strengths as follows:

[1] Copies may be obtained from American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, Michigan 49085.

10 mm x 10 mm specimen: 8 ft.-lb. at −20° F.
10 mm x 7.5 mm specimen: 7 ft.-lb. at −20° F.
10 mm x 5 mm specimen: 5.5 ft.-lb. at −20° F.
10 mm x 2.5 mm specimen: 4 ft.-lb. at −20° F.

Specimens shall be longitudinal and taken from flat stock, tubular, or structural sections before forming or welding for use in the frame. Specimens from tubular or structural sections shall be taken from the middle of the side of greatest dimension, not to include welds.

(2) *Static test performance requirements.* In addition to meeting the requirements of paragraph (e)(1) of this section in both side and rear loads, $FER_{ls}$ and $FER_{lr}$ shall be greater than 1, and where the ROPS contains 1 or 2 upright frames only, *FSB* shall be greater than 1.3.

(3) *Dynamic test performance requirements.* The structural requirements will be met where the dimensions in paragraph (e)(1) of this section are adhered to in both side and rear loads.

(4) *Field upset test performance requirements.* The requirements of paragraph (e)(1) of this section shall be met in both side and rear upsets.

**§ 1928.53 Protective enclosures for wheel type agricultural tractors—test procedures and performance requirements.**

(a) *Purpose.* The purpose of this section is to establish the test and performance requirements for a protective enclosure designed for wheel type agricultural tractors to minimize the frequency and severity of operator injury resulting from accidental upset. General requirements for the protection of operators are specified in § 1928.51.

(b) *Types of tests.* All protective enclosures for wheel type agricultural tractors shall be of a model which has been tested as follows:

(1) *Laboratory test.* A laboratory energy absorption test, either static or dynamic, under repeatable and controlled loading, to permit analysis of the protective enclosure for compliance with the performance requirements of this standard.

(2) *Field upset test.* A field upset test under controlled conditions, both to the side and rear, to verify effectiveness of the protective system under actual dynamic conditions. This test may be omitted where:

(i) The analysis of the protective frame static energy absorption test results indicates that both $FER_{ls}$ and $FER_{lr}$ (as defined in paragraph (d)(2)(ii) of this section) exceed 1.15; or

(ii) The analysis of the protective frame dynamic energy absorption test results indicates that the frame can withstand an impact 15 percent greater than the impact it is required to withstand for the tractor weight as shown in Fig. C–7.

(c) *Description.* A protective enclosure is a structure comprising a frame and/or enclosure mounted to the tractor. A typical protective enclosure is shown in Figure C–12.

(d) *Test procedures*—(1) *General.* (i) The tractor weight used shall be that of the heaviest tractor model on which the protective enclosure is to be used.

(ii) Each test required under this section shall be performed on a protective enclosure with new structural members. Mounting connections of the same design shall be used during each test.

(iii) Instantaneous deflection shall be measured and recorded for each segment of the test. See paragraph (e)(1)(i) of this section for permissible deflection.

(iv) Seat reference point (*SRP*) in Fig. C–14) is that point where the vertical line that is tangent to the most forward point at the longitudinal seat centerline of the seat back, and the horizontal line that is tangent to the highest point of the seat cushion intersect in the longitudinal seat section. The seat reference point shall be determined with the seat unloaded and adjusted to the highest and most rearward position provided for seated operations of the tractor.

(v) Where the centerline of the seat is off the longitudinal center, the protective enclosure loading shall be on the side with least space between the centerline of the seat and the protective enclosure.

(vi) Low temperature characteristics of the protective enclosure or its material shall be demonstrated as specified in paragraph (e)(1)(ii) of this section.

(vii) Rear input energy tests (static, dynamic, or field upset) need not be performed on enclosures mounted to tractors having 4 driven wheels and more than one-half their unballasted weight on the front wheels.

(viii) Accuracy table:

| *Measurements* | *Accuracy* |
|---|---|
| Deflection of enclosure, inches (millimeters) | ±5 percent of deflection measured. |
| Vehicle weight, pounds (kilograms) | ±5 percent of the weight measured. |
| Force applied to frame, pounds force (newtons). | ±5 percent of force measured. |
| Dimensions of critical zone, inches (millimeters). | ±0.5 inch (12.5 millimeters). |

(ix) Where movable or normally removable portions of the enclosure add to structural strength, they shall be placed in configurations that contribute least to the structural strength during the test.

(2) *Static test procedure.* (i) The following test conditions shall be met:

(A) The laboratory mounting base shall be the tractor chassis for which the protective enclosure is designed or its equivalent.

(B) The protective enclosure shall be instrumented with the necessary equipment to obtain the required load deflection data at the locations and directions as specified in Figs. C–13 and C–14.

(ii) The following definitions shall apply:

$W$ = Tractor weight (see § 1928.51 (a)) in lb. ($W'$ in kg.).
$E_{ts}$ = Energy input to be absorbed during side loading in ft-lb ($E'_{ts}$ in m-kg.).
$E_{ts} = 723 + 0.4\ W$ ($E'_{ts} = 100 + 0.12\ W'$).
$E_{tr}$ = Energy input to be absorbed during rear loading in ft-lb ($E'_{tr}$ in m-kg.).
$E_{tr} = 0.47\ W$ ($E'_{tr} = 0.14\ W'$).
$L$ = Static load, lbf (N)
$D$ = Deflection under $L$, in. (mm).
$L$–$D$ = Static load-deflection diagram.
$L_{max}$ = Maximum observed static load.
Load Limit = Point on a continuous $L$–$D$ curve where observed static load is 0.8 $L_{max}$ on down slope of curve (refer to Fig. C–5)
$E_a$ = Strain energy absorbed by the protective enclosure, ft-lb (m-kg.). Area under $L$–$D$ curve.
*FER* = Factor of energy ratio.

$$FER_{ls} = \frac{E_a}{E_{ts}}$$

$$FER_{lr} = \frac{E_a}{E_{tr}}$$

(iii) The test procedures shall be as follows:

(A) When the protective frame structures are not an integral part of the enclosure, the direction and point of load application for both side and rear shall be the same as specified in § 1928.52 (d)(2).

(B) When the protective frame structures are an integral part of the enclosure, apply the rear load in accordance with Fig. C–14 and record $L$ and $D$ simultaneously. Rear load application shall be uniformly distributed on the frame structure over an area perpendicular to the load application, no greater than 160 sq. in. (1032 sq. cm.) in size with a largest dimension no greater than 27 in. (686 mm). The load shall be applied to the upper extremity of the structure at the point which is midway between the centerline of the protective enclosure and the inside of the protective structure. If no structural cross member exists at the rear of the enclosure, a substitute test beam which does not add strength to the structure may be utilized to complete this test procedure. The test shall be stopped when:

(1) The strain energy absorbed by the structure is equal to or greater than the required input energy $E_{tr}$ or;

(2) Deflection of the structure exceeds the allowable deflection, (see paragraph (e)(1)(i) of this section) or;

(3) The structure load limit (see Fig. C–5) occurs before the allowable deflection is reached in rear load.

(C) Using data obtained in paragraph (d)(2)(iii)(B) of this section, construct the $L$–$D$ diagram for rear loads as shown typically in Fig. C–5.

(D) Calculate $E_{tr}$.

(E) Calculate $FER_{lr}$.

(F) When the protective frame structures are an integral part of the enclosure, apply the side load in accordance with Fig. C–13 and record $L$ and $D$ simultaneously. Static side load application shall be uniformly distributed on the frame over an area perpendicular to the direction of load application, and no

greater than 160 sq. in. (1032 sq. cm.) in size, with a largest dimension no greater than 27 in. (686 mm). Side load application shall be at a 90 degree angle to the center line of the vehicle. The center of side load application shall be located between a point "*k*", 24 in. (610 mm) forward; and point "*l*", 12 in. (305 mm) rearward of the seat reference point to best utilize the structural strength (see Fig. C–13). This side load shall be applied to the longitudinal side farthest from the point of rear load application. The test shall be stopped when:

(*1*) The strain energy absorbed by the structure is equal to or greater than the required input energy $E_{is}$; or

(*2*) Deflection of the structure exceeds the allowable deflection (see paragraph (e) (1) (i) of this section); or

(*3*) The structure load limit (see Figure C–5) occurs before the allowable deflection is reached in side load.

(G) Using data obtained in paragraph (d) (2) (iii) (F) of this section construct the *L–D* diagram for side load as shown typically in Fig. C–5.

(H) Calculate $FER_{is}$.

(I) Calculate $FER_{is}$.

(3) *Dynamic test procedure.* (i) The following test conditions shall be met:

(A) The protective enclosure and tractor shall be tested at the weight defined in § 1928.51(a).

(B) The dynamic loading shall be accomplished by use of a 4410 lb. (2000 kg) weight acting as a pendulum. The impact face of the weight shall be 27±1 in. by 27±1 in. (686±25 mm by 686±25 mm) and shall be constructed so that its center of gravity is within 1 in. (25.4 mm) of its geometric center. The weight shall be suspended from a pivot point 18 to 22 ft. (5.5–6.7 m) above the point of impact on the enclosure and shall be conveniently and safely adjustable for height. (See Fig. C–6).

(C) For each phase of testing, the tractor shall be restrained from moving when the dynamic load is applied. The restraining members shall have strength no less than, and elasticity no greater than that of 0.50 in. (12.7 mm) steel cable. Points of attachment of restraining members shall be located an appropriate distance behind the rear axle and in front of the front axle to provide a 15 to 30 degree angle between the restraining cable and the horizontal. For the impact from the rear, the restraining cables shall be located in the plane in which the center of gravity of the pendulum will swing, or alternatively, two sets of symmetrically located cables may be used at lateral locations on the tractor. For the impact from the side, restraining cables shall be used as shown in Figures C–15 and C–16.

(D) The front and rear wheel tread stttings, where adjustable, shall be at the position nearest to halfway between the minimum and maximum settings obtainable on the vehicle. Where only two settings are obtainable, the minimum setting shall be used. The tires shall have no liquid ballast and shall be inflated to the maximum operating pressure recommended by the manufacturer. With specified tire inflation, the restraining cable shall be tightened to provide tire deflection of 6 to 8 percent of nominal tire section width. After the vehicle is properly restrained, a wooden beam no smalled than 6 x 6 in. (150 x 150 mm) cross-section shall be driven tightly against the appropriate wheels and clamped. For the test to the side, an additional wooden beam shall be placed as a prop against the wheel nearest the operator's station and shall be secured to the base so that it is held tightly against the wheel rim during impact. The length of this beam shall be chosen so that it is at an angle of 25 to 40 degrees to the horizontal when its is positioned against the wheel rim. It shall have a length 20 to 25 times its depth and width 2 to 3 times its depth. (See Figs. C–15 and C–16.)

(E) Means shall be provided for indicating the maximum instantaneous deflection along the line of impact. A simple friction device is illustrated in Fig. C–4.

(F) No repairs or adjustments shall be made during the test.

(G) If any cables, props, or blocking shift or break during the test, the test shall be repeated.

(ii) $H$=Vertical height of center of gravity of 4410 lb. (2000 kg) weight in inches ($H'$ in mm). The weight shall be pulled back so that the height of its center of gravity above the point of impact is: $H=4.92+0.00190\ W$ or ($H'=125+0.107\ W'$). (Fig. C–7.)

(iii) The test procedures shall be as follows:

(A) The enclosure structure shall be evaluated by imposing dynamic loading from the rear followed by a load to the side on the same enclosure structure. The pendulum swinging from the height determined by paragraph (d) (3) (ii) of this section shall be used to impose the dynamic load. The position of the pendulum shall be so selected that the initial point of impact on the protective structure is in line with the arc of travel of the center of gravity of the pendulum. Where a quick release mechanism is used, it shall not influence the attitude of the block.

(B) Impact at rear: The tractor shall be properly restrained in accordance with paragraphs (d) (3) (i) (C) and (d) (3) (i) (D) of this section. The tractor shall be positioned with respect to the pivot point of the pendulum so that the pendulum is 20 degrees from the vertical prior to impact as shown in Fig. C–15. The impact shall be applied to the upper extremity of the enclosure structure at the point which is midway between the center line of the enclosure structure and the inside of the protective structure. If no structural cross member exists at the rear of the enclosure structure, a substitute test beam which does not add to the strength of the structure may be utilized to complete the test procedure.

(C) Impact at side: The blocking and restraining shall conform to paragraphs (d) (3) (i) (C) and (d) (3) (i) (D) of this section. The center point of impact shall be at the upper extremity of the enclosure at a 90° angle to the centerline of the vehicle and located between a point "*k*", 24 in. (610 mm) forward, and a point "*l*", 12 in. (305 mm) rearward of the seat reference point, to best utilize the structural strength. (See Fig. C–13.) The side impact shall be applied to the longitudinal side farthest from the point of rear impact.

(4) *Field upset test procedure.* (i) The following test conditions shall be met.

(A) The tractor shall be tested at the weight as defined in § 1928.51(a).

(B) The test shall be conducted on a dry, firm soil bank. The soil in the impact area shall have an average cone index in the 0 to 6 in. (0 to 152 mm) layer of not less than 150. Cone index shall be determined in accordance with American Society of Agricultural Engineers Recommendation ASAE R313.1, Soil Cone Penetrometer (1971).[1] The path of vehicle travel shall be 12±2 degrees to the top edge of bank.

(C) An 18 in. (457 mm) high ramp as described in Fig. C–10 shall be used to assist in upsetting the vehicle to the side.

(D) The front and rear wheel tread settings, where adjustable, shall be at the position nearest to halfway between the minimum and maximum settings obtainable on the vehicle. Where only two settings are obtainable, the minimum setting shall be used.

(ii) Field upsets shall be induced to the rear and side.

(A) Rear upset shall be induced by engine power with the tractor operating in a gear to obtain 3 to 5 mph (4.8 to 8.0 km per hour) at maximum governed engine rpm, by driving forward directly up a minimum slope of 60°±5° as shown in Fig. C–11 or by an alternate equivalent means. The engine clutch may be used to aid in inducing the upset.

(B) To induce side upset, the tractor shall be driven under its own power along the specified path of travel at a minimum speed of 10 mph (16 km per hour), or at maximum vehicle speed if under 10 mph (16 km per hour), and over the ramp as described in paragraph (d) (4) (i) (C) of this section.

(e) *Performance requirements* — (1) *General requirements.*

(i) The protective enclosure structural members or other parts in the operator area may be deformed in these tests but shall not shatter or leave sharp edges exposed to the operator. They shall not encroach on a transverse plane passing through points *d* and *f* within the projected area defined by dimensions *d*, *e*, and *g* or on the dimensions shown in Figs. C–13, and C–14, as follows:

$d$=2 in. (51 mm) inside of protective structure to vertical centerline of seat.

$e$=30 in. (762 mm) at the longitudinal centerline.

$f$=Not greater than 4 in. (102 mm) measured forward of seat reference point (*SRP*) at the longitudinal centerline as shown in Fig. C–14.

[1] Copies may be obtained from American Society of Agricultural Engineers, 2950 Nils Road, St. Joseph, Michigan 49085.

$g$=24 in. (610 mm) minimum.
$h$=17.5 in. (445 mm) minimum.
$j$=2.0 in. (51 mm) measured from outer periphery of steering wheel.

(ii) The protective structure and connecting fasteners must pass the static or dynamic tests described in paragraphs (d)(2), (d)(3), or (d)(4) of this section at a metal temperature of 0 degrees fahrenheit or below, or exhibit Charpy V-notch impact strengths as follows:

10 mm x 10 mm specimen: 8 ft.-lb. at −20° F.
10 mm x 7.5 mm specimen: 7 ft.-lb. at −20° F.
10 mm x 5 mm specimen: 5.5 ft.-lb. at −20° F.
10 mm x 2.5 mm specimen: 4 ft.-lb. at −20° F.

Specimens shall be longitudinal and taken from flat stock, tubular, or structural sections before forming or welding for use in the protective enclosure. Specimens from tubular or structural sections shall be taken from the middle of the side of greatest dimension, not to include welds.

(iii) Glazing shall conform to the requirements contained in Society of Automotive Engineers Standard SAE J674, Safety Glazing Materials (1963).[3]

(iv) Two or more operator exits shall be provided and positioned to avoid the possibility of both being blocked by the same accident.

(2) *Static test performance requirements.* In addition to meeting the requirements of paragraph (e)(1) of this section in both side and rear loads, $FER_s$ and $FER_r$ shall be greater than 1.

(3) *Dynamic test performance requirements.* The structural requirements will be met where the dimensions in paragraph (e)(1) of this section are adhered to in both side and rear loads.

(4) *Field upset test performance requirements.* The requirements of paragraph (e)(1) of this section shall be met in both side and rear upsets.

APPENDIX A—EMPLOYEE OPERATING INSTRUCTIONS

1. Securely fasten your seat belt if the tractor has a ROPS.
2. Where possible, avoid operating the tractor near ditches, embankments, and holes.
3. Reduce speed when turning, crossing slopes, and on rough, slick, or muddy surfaces.
4. Stay off slopes too steep for safe opefation.
5. Watch where you are going, especially at row ends, on roads, and around trees.
6. Do not permit others to ride.
7. Operate the tractor smoothly—no jerky turns, starts, or stops.
8. Hitch only to the drawbar and hitch points recommended by tractor manufacturers.
9. When tractor is stopped, set brakes securely and use park lock if available.

[3] Copies may be obtained from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pa. 15096.

APPENDIX B—FIGURES C-1—C-16

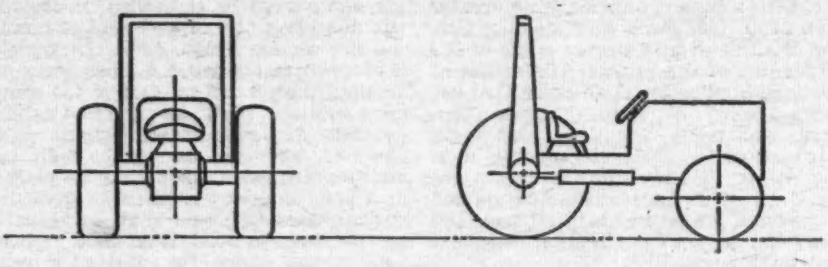

Fig. C-1 TRACTOR WITH TYPICAL PROTECTIVE FRAME

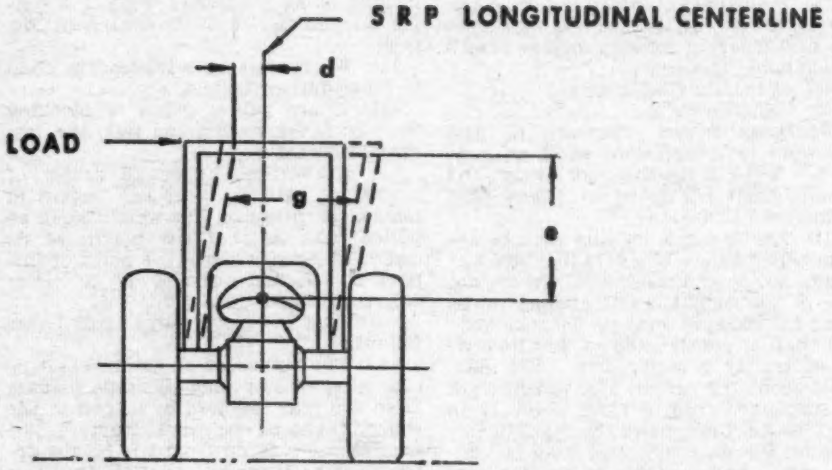


Fig. C-2 SIDE LOAD APPLICATION

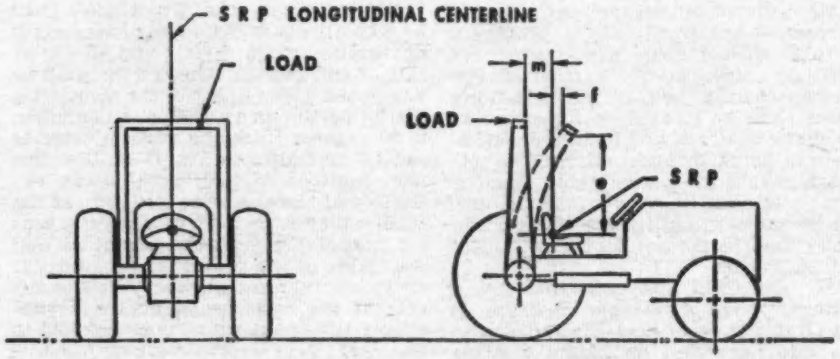


Fig. C-3 REAR LOAD APPLICATION

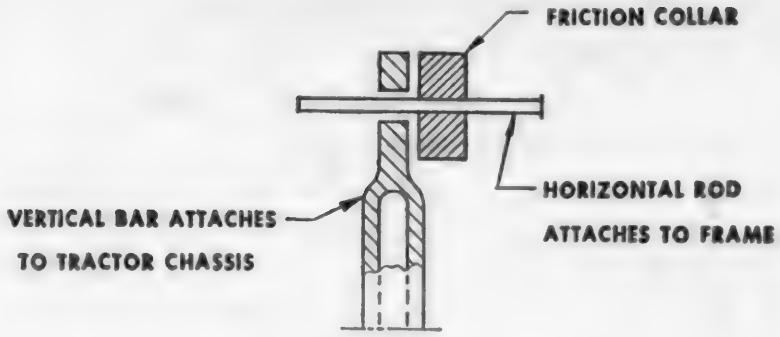


Fig. C-4 TYPICAL METHOD OF MEASURING DEFLECTION

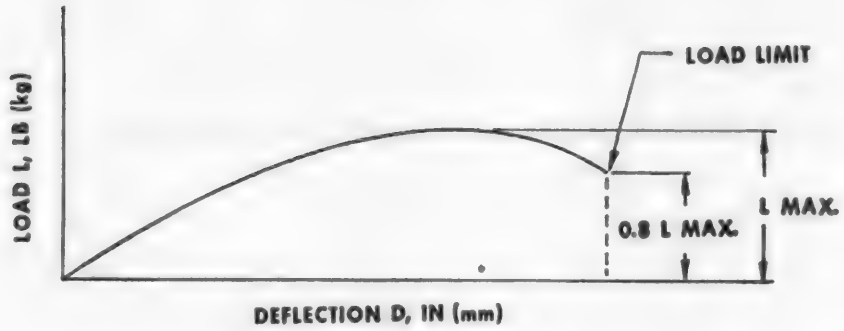


Fig. C-5 TYPICAL L-D DIAGRAM

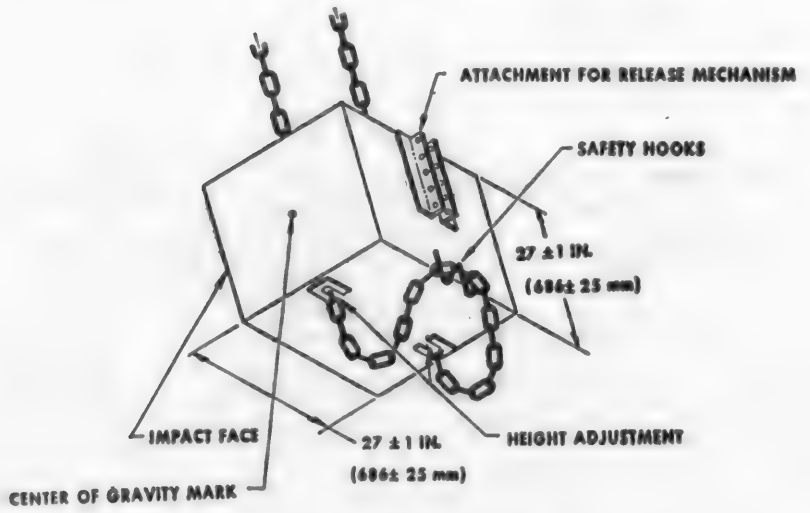


Fig. C-6 PENDULUM

NOTATION OF FORMULAE

$H = 4.92 + 0.00190\ W$ OR ($H' = 125 + 0.107\ W'$)

W = TRACTOR WEIGHT AS DEFINED IN PARAGRAPH 3.2 IN POUNDS ($W'$ = kg)

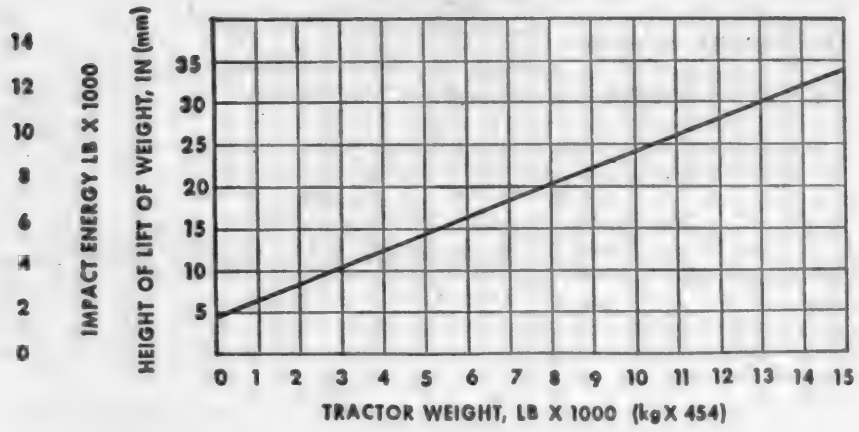


FIG. C-7 IMPACT ENERGY AND CORRESPONDING LIFT HEIGHT OF 4410 LB. (2000 kg) WEIGHT

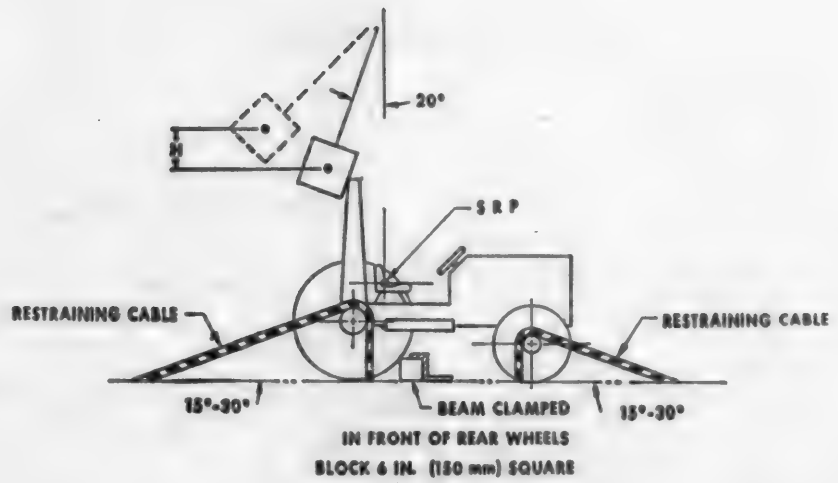


Fig. C-8 REAR IMPACT APPLICATION

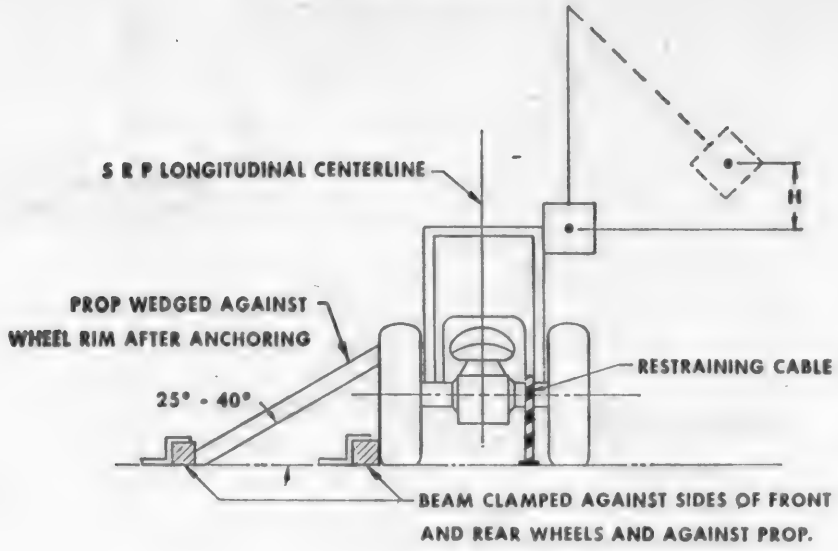


Fig. C-9 SIDE IMPACT APPLICATION

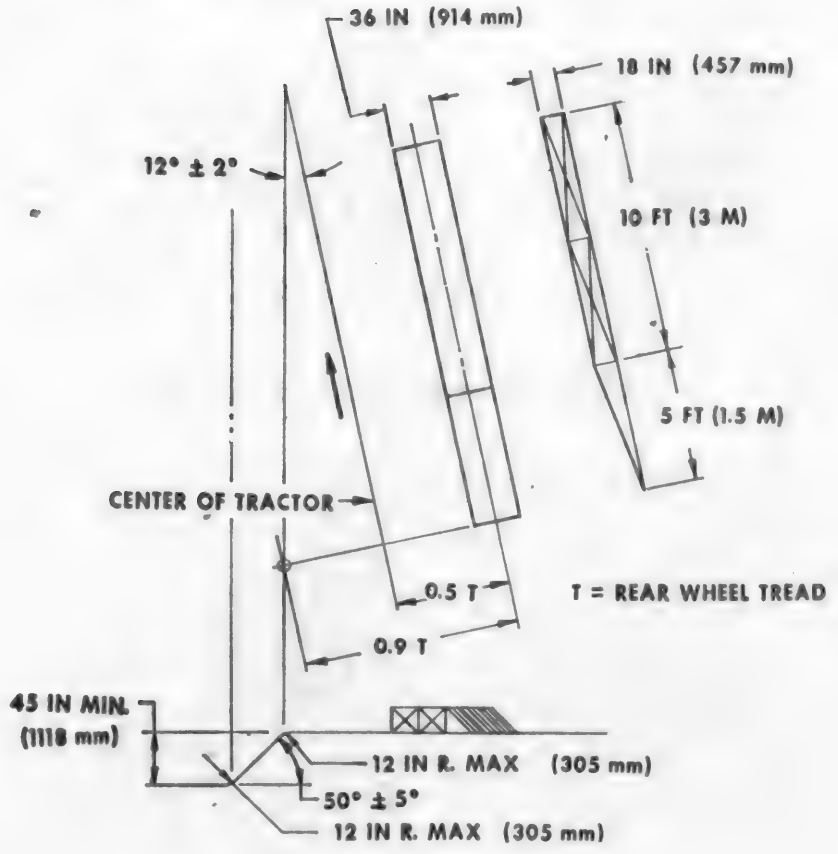


Fig. C-10 SIDE OVERTURN BANK AND RAMP

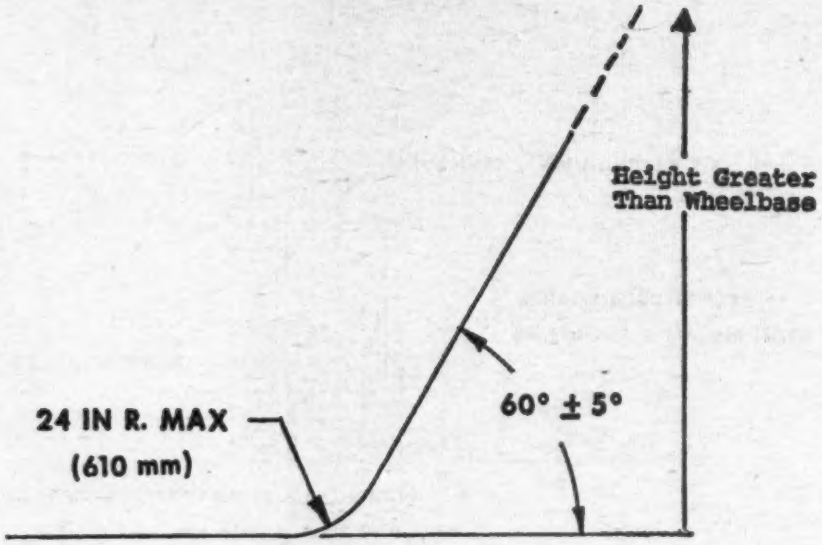


Fig. C-11 **TYPICAL REAR OVERTURN BANK**

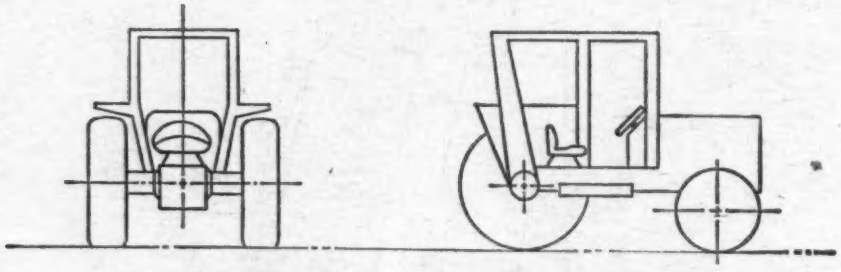

Fig. C-12 **TRACTOR WITH TYPICAL PROTECTIVE ENCLOSURE**

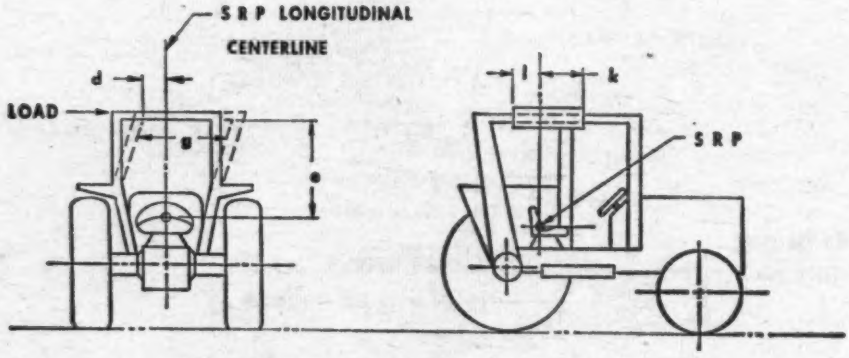


Fig. C-13 **SIDE LOAD APPLICATION**

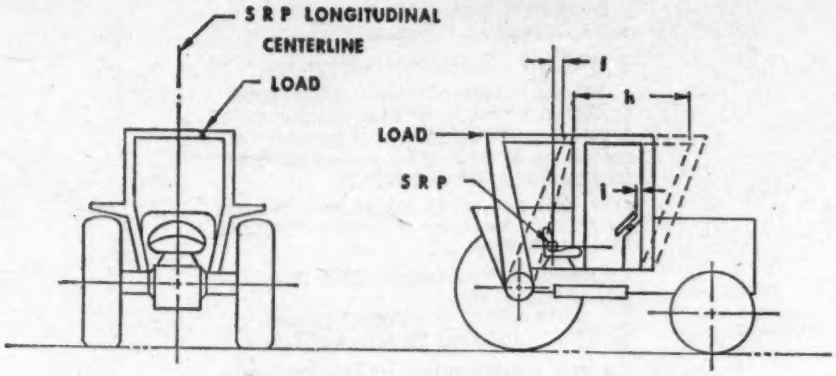


Fig. C-14 **REAR LOAD APPLICATION**

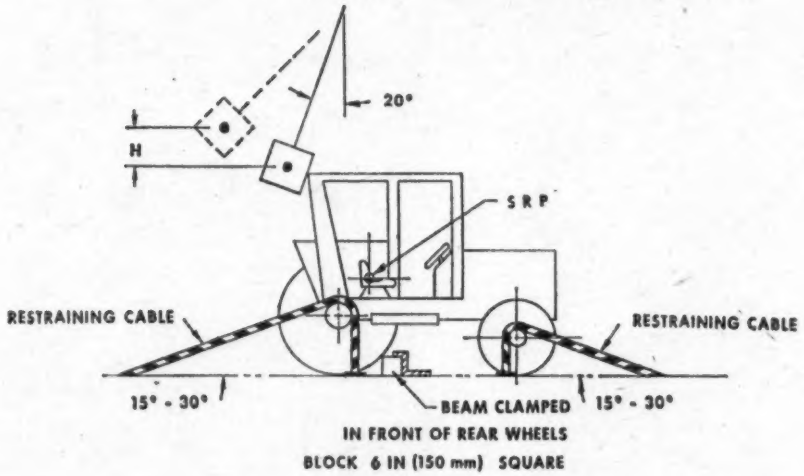


Fig. C-15 **REAR IMPACT APPLICATION**

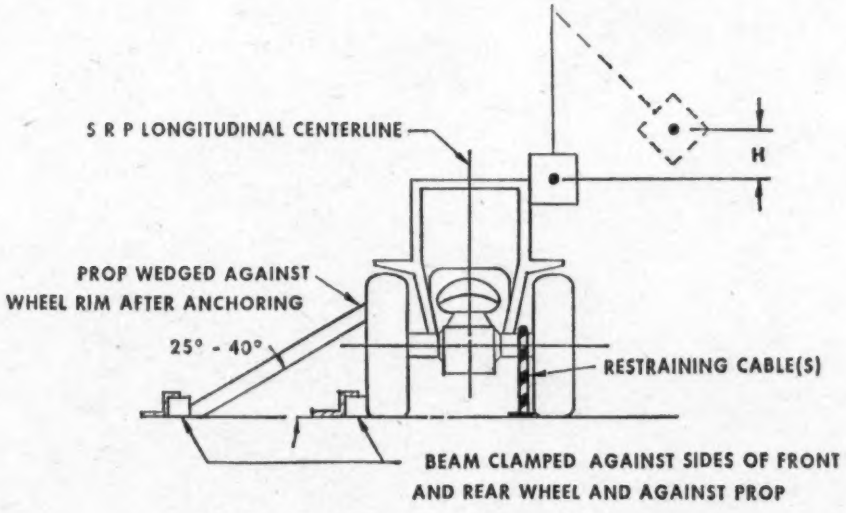


**FIG. C-16 SIDE IMPACT APPLICATION**

In 29 CFR Part 1910, § 1910.267 is revised to read as follows:

**§ 1910.267 Agricultural operations.**

[These standards have been transferred to § 1928.21 of this chapter.]

*Effective date.* This part becomes effective on June 1, 1975, except as noted in paragraph (b) of § 1928.51.

(Sec. 6(b), Pub. L. 91-596, 84 Stat. 1593 (29 U.S.C. 655), Secretary of Labor's Order No. 12-71, 36 FR 8754)

Signed at Washington, D.C. this 16th day of April 1975.

JOHN STENDER,
*Assistant Secretary of Labor.*

NOTE: Incorporation by reference provisions approved by the Director of the Federal Register on April 21, 1975.

[FR Doc.75-10549 Filed 4-24-75;8:45 am]